

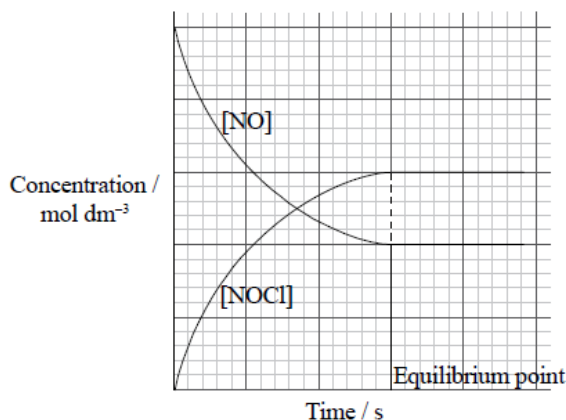
Topic 07/17 HL Review – Equilibrium (2011 Exam) MS

1. D
2. B
3. B
4. C
5. D
6. C
7. C
8. D
9. C
10. D
11. C
12. C
13. B
14. B
15. B
16. C
17. A
18. B
19. B
20. D
21. D
22. D
23. A
24. B
25. D
26. D
27. D
28. (i) CO = 0.4 (mol);
H₂O = 1.6 (mol);
 $K_C (= 1.6^2 \div 0.4 \times 1.6) = 4.0/4;$ 3
Apply ECF from K_C expression.
Ignore units.
(ii) H₂ and CO₂/products = 1.33/1.3 (mol);
CO and H₂O/reactants = 0.67/0.7 (mol); 2
Using $K_C = 9.0$, values for H₂ and CO₂ are 1.5 and values for CO and H₂O are 0.5.
29. (Mixture will get) darker/darker than expected;
equilibrium position moves to the left/towards reactants as there is an
increase in the number of moles of gas from right to left; 2

[5]

[2]

30. (a) (i) $\text{rate} = k [\text{NO}]^2 [\text{Cl}_2]$; **[1]**
 (ii) rate of reaction will decrease by a factor of 4;
 no effect on the rate constant; **[2]**
 (iii) y axis labeled concentration/mol dm⁻³ and x axis is labeled time/s;
 gradient for [NO];
 gradient for [NOCl] will be equal and opposite;
 equilibrium point identified / two curves level off at same time; **[4]**



- (b) Above 775 K: $\text{rate} = k [\text{NO}_2][\text{CO}]$;
 Below 775 K: $\text{rate} = k [\text{NO}_2]^2$; **[2]**
- (c) zero order reaction;
 all concentrations are 1.0 mol dm⁻³; **[2]**
- (d) slope = $(9.2 - 8.4) / [(3.53 - 3.65) \times 10^{-3}] = 6.67 \times 10^3$
 $(E_a = 6.67 \times 10^3 \times 8.31)$
 $55.4 \text{ (kJ mol}^{-1}\text{)}; \text{ [2]}$
Accept in range 55.0 – 56.0
Award [1] if 55454 (J) stated
Award [2] for the correct final answer
- (e) (i) $K_c = [\text{SO}_2\text{Cl}_2] / ([\text{Cl}_2][\text{SO}_2])$ **[1]**
Ignore state symbols.
Square brackets [] required for the equilibrium expression.
- (ii) $7.84 \times 10^{-3} \text{ mol of SO}_2$ and $7.84 \times 10^{-3} \text{ mol of Cl}_2$;
 $7.84 \times 10^{-3} \text{ mol dm}^{-3} \text{ of SO}_2$, $7.84 \times 10^{-3} \text{ mol dm}^{-3} \text{ of Cl}_2$ and
 $7.65 \times 10^{-4} \text{ mol dm}^{-3} \text{ of SO}_2\text{Cl}_2$;
 12.5; **[3]**
Award [1] for 10.34
Award [3] for the correct final answer
- (iii) value of K_c increases;
 $[\text{SO}_2\text{Cl}_2]$ increases;
 decrease in temperature favors (forward) reaction which is exothermic; **[3]**
Do not allow ECF.
- (iv) no effect on the value of K_c / depends only on temperature;
 $[\text{SO}_2\text{Cl}_2]$ decreases;
 increase in volume favors the reverse reaction which has more gaseous moles; **[3]**
Do not allow ECF.
- (v) no effect;
 Catalyst increases the rate of forward and reverse reactions (equally) / catalyst decreases activation energies (equally); **[2]**